ELECTRONIC DEVICE WIDE BAND ANTENNAS

BACKGROUND

[0001] This relates to electronic devices and, more particularly, to electronic devices with wireless communications circuitry.

[0002] Electronic devices are often provided with wireless communications capabilities. To satisfy consumer demand for small form factor wireless devices, manufacturers are continually striving to implement wireless communications circuitry such as antenna components using compact structures. At the same time, there is a desire for wireless devices to cover a growing number of communications bands.

[0003] Because antennas have the potential to interfere with each other and with components in a wireless device, care must be taken when incorporating antennas into an electronic device. Moreover, care must be taken to ensure that the antennas and wireless circuitry in a device are able to exhibit satisfactory performance over a range of operating frequencies.

[0004] It would therefore be desirable to be able to provide improved wireless communications circuitry for wireless electronic devices.

SUMMARY

[0005] An electronic device such as a wristwatch device may have a housing with metal portions such as metal sidewalls. A metal sidewall may have an elongated slot. The electronic device may include an electronic component module such as a speaker module having a (speaker) module housing member with (speaker) module housing walls. One or more speaker housing walls may have conductive structures formed on respective external surfaces of the speaker housing walls. The conductive structures may have an elongated opening that is aligned with the elongated slot in the metal sidewall. The speaker housing member may have a cavity defined by an interior surface of the speaker housing member and extending to an open end at the opening. The conductive structure may surround the cavity. The conductive structure may be grounded to the metal sidewall. The opening in the conductive structures may form a slot antenna resonating element for an antenna. An antenna feed structure may be disposed in the opening. The slot antenna resonating element may be backed by the cavity. The antenna formed from the slot antenna resonating element, the antenna feed structure, and the cavity, may be a cavity-backed indirectly-fed slot antenna.

[0006] The antenna may include an antenna feed having a positive antenna feed terminal coupled to the antenna feed structure and a ground antenna feed terminal coupled to the conductive structures. Transceiver circuitry may be coupled to antenna feed using a transmission line structure and may be configured to operate the antenna in an ultra-wideband communications (frequency) band between a frequency of 5 GHz and a frequency of 8.5 GHz. The antenna feed structure may directly receive antenna signals and may be configured to induce current to flow around a perimeter of the opening in the conductive structures. The antenna feed structure may have first and second opposing edges that are respectively coupled indirectly (capacitively) to first and second opposing edges of the opening in the conductive structure.

[0007] The electronic device may include a liquid barrier interposed between and aligned with the elongated slot in the metal sidewall and the elongated opening in the conductive structures. The liquid barrier may serve as a water seal (sealant) configured to prevent water from entering an interior of the electronic device. The speaker housing member may be mounted to the metal sidewall using an attachment structure such as conductive tape and may be held in place using a retaining member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a front perspective view of an illustrative electronic device with wireless circuitry in accordance with some embodiments.

[0009] FIG. **2** is a schematic diagram of an illustrative electronic device with wireless circuitry in accordance with some embodiments.

[0010] FIG. **3** is a diagram of illustrative wireless circuitry in an electronic device in accordance with some embodiments.

[0011] FIG. **4** is a schematic diagram of an illustrative slot antenna in accordance with some embodiments.

[0012] FIG. **5** is a schematic diagram of an illustrative indirectly-fed slot antenna in accordance with some embodiments.

[0013] FIG. **6** is a front perspective view of an illustrative electronic component module having conductive walls and a cavity that are used to form an antenna in accordance with some embodiments.

[0014] FIG. **7** is a cross-sectional side view of an illustrative electronic device having an antenna of the type shown in FIG. **6** in accordance with some embodiments.

[0015] FIG. **8** is a graph of antenna performance (antenna efficiency) for illustrative antenna structures of the types shown in FIGS. **5-7** in accordance with some embodiments.

DETAILED DESCRIPTION

[0016] An electronic device such as electronic device **10** of FIG. **1** may be provided with wireless circuitry. The wireless circuitry may be used to support wireless communications in multiple wireless communications (frequency) bands. The wireless circuitry may include antennas. Antennas may be formed from electronic components such as displays, touch sensors, near-field communications antennas, wireless power coils, peripheral antenna resonating elements, conductive traces, and device housing structures, electronic component modules, as examples.

[0017] Electronic device **10** may be a computing device such as a laptop computer, a computer monitor containing an embedded computer, a tablet computer, a cellular telephone, a media player, or other handheld or portable electronic device, a smaller device such as a wristwatch device, a pendant device, a headphone or earpiece device, a device embedded in eyeglasses or other equipment worn on a user's head, or other wearable or miniature device, a television, a computer display that does not contain an embedded computer, a gaming device, a navigation device, an embedded system such as a system in which electronic equipment with a display is mounted in a kiosk or automobile, equipment that implements the functionality of two or more of these devices, or other electronic equipment. In the illustrative configuration of FIG. **1**, device **10** is a portable device such